INTERESTING FEATURES

OF

LONE STAR'S SEATTLE PLANT

QUESTION

2a.

S. G.

G.

Seattle, Washington

For Presentation At The

I.E.E.E. Cement Industry Technical Conference

May 11-13, 1971

Seattle, Washington, U.S.A.

OPERATION DESCRIPTION

1. INTRODUCTION

The Seattle Plant was built in 1928 by the Pacific Coast Chemical Company, later becoming Superior Portland Cement Company. Lone Star Cement Corporation took over the operation in 1957, at which time the Seattle Plant consisted of two kilns and three mills producing 1.2 million barrels per year. An expansion and modernization program began in 1968 and the new facilities went into operation in April, 1969. This project included eight new clinker storage silos, two finish mills, eight cement storage silos plus new bulk loading facilities. During the construction period, normal production and shipping was maintained.

2. RAW MATERIAL HANDLING & CRUSHING

The Seattle Plant is supplied with limerock from a quarry on Texada Island, some two hundred miles north of Seattle. The 5,000 Ton open barges are unloaded by a Hammerhead crane with a one hundred foot boom and a five and one-half yard bucket. The crane is on rails and is capable of moving all raw materials either to storage, to the crusher feeders, or directly to the mill feed bins. It is also utilized to unload rail cars and service the kilns and coolers during repairs.

The minus 4" limerock, slag and silica is delivered to the four and one-quarter foot cone crusher through two reciprocating feeders whose instruments are controlled and set by the Laboratory. 24" conveyor belts and a rail mounted tripper delivers the raw mix to the mill feed bins. All controls for the crushing system are located on a schematic control panel in the raw mill building. Tripper position and feed bin level are monitored by closed circuit television.

The complete raw system from barge unloading to the mill feed bins has automatic water spray dust suppression control.

3. RAW MATERIAL GRINDING

Two of the three 7' x 45' three compartment mills are used for raw grinding. The third is used for masonry cement grinding. One raw mill is a combination Rod and Ball mill. All are driven by 750 H.P. Super Synchronous motors. The mills are fed from individual feed bins with weigh belt conveyors.

The slurry is pumped to any of six storage and blending basins by a 5" pump. A nuclear density gauge monitors the mill discharge and maintains the desired moisture content.

4. KILN FEED

One kiln feed tank, equipped with mechanical and air agitation supplies feed for the kilns.

A 4" slurry pump feeds a single surge tank which in turn delivers slurry to individual ferris wheel feeders for each kiln. A nuclear density gauge controls the per cent solids in the kiln feed. The kiln feed is ratioed to the kiln speed by a generator driven off the main kiln drive delivering power to the slurry feeder motor.

5. DUST HANDLING

The dust laden gas from the kiln passes through individual dust chambers, multiclones, louvre dampers and 90,000 CFM draft fans to a common three section electrostatic precipitator and is exhausted through a 12' x 17' x 200' concrete stack. Dust is reclaimed by screw conveyors to an elevator and pug mills. Waste water and molasses are added and the dust slurry is pumped to the raw mill by a 4" pump. This dust slurry is the primary water supply for the raw grinding.

6. KILN AND CLINKER COOLERS

The two rotary kilns are 11' 3" x 240' and each is supported on four piers and driven by 2300 volt motors through reduction gears. Continuous recorded temperatures are obtained from a series of thermocouples located at the draft fans, dust chambers, and after chain areas plus optical pyrometers at the discharge end. Other instruments used are gas analyzers for O_2 content, kiln tachometers, natural gas flow, hood and feed end draft, damper settings and slurry density control.

The two clinker coolers are 9' x 90' rotary type discharging to a common drag chain and elevator to a 100,000 barrel clinker storage building.

7. CLINKER STORAGE AND HANDLING

A bridge crane with a three yard bucket stockpiles or transfers clinker to a feed hopper. From the feed hoppers, belt conveyors and an elevator transports the clinker to the new storage silos.

The six clinker storage silos have a capacity of 25,000 barrels each. There are two interstices, one used for gypsum and the other for special clinker. The silos are equipped with hi-level indicators, self-closing inlets and three dust collectors.

Clinker production is supplemented with clinker processed by contract to Lone Star specifications and shipped to the plant in a 263' self unloading barge built specifically for this service. The clinker is discharged from the barge into a hopper and boom conveyor designed to compensate for the 19' tide changes. The covered 36" conveyors discharge to any of the six silos at the rate of 1,200 tons per hour. An instrument showing rate (tons per hour) and total tons over the belt keeps both the barge personnel and mill control operator informed on the unloading. There are dust collectors on the unloading hopper, each transfer point and three for the clinker silos.

All controls for the transferring and barge unloading are located in the mill control room.

Clinker and gypsum are reclaimed by vibrating feeders below each silo. A belt conveyor system transports clinker or gypsum to the finish mill feed bins in the mill building via conveyor belts.

8. FINISH GRINDING

The finish department consists of two duplicate closed circuit grinding systems, each independent of the other. There are two 900 barrel feed bins for each of the two mills and a common 200 ton gypsum bin.

Six weigh feeders deliver the desired proportions of clinker and gypsum to 24" mill feed conveyors, which feed the two 12' x 34' two compartment ball mills.

The mills are driven by 2,500 H.P. synchronous motors through air clutches and symotro drives. Each mill has internal cooling and pressure lubrication. The mills discharge to a pneumatic conveyor, then to bucket elevators. The elevators discharge into 18' air separators. The separators discharge into a common fringe bin or air slide to two pairs of 6-1/2' x 17-1/2' cement coolers. Tailings are returned by a 20" screw conveyor mounted on load cells, so that any variation in the return rate is electrically transmitted to a master feed control system to maintain a preset total feed to the mill. Cement is pumped by 7" pumps to any selected silo in the new group or to a transfer station from which it is pumped to the old silo group.

A vacuum cleaning system is used to clean up dust. There are seven dust collectors in the mill building.

Controls for clinker unloading, transferring clinker, silo selection, both for clinker and cement and finish mill operation are all located in an air conditioned control room in the finish mill building.

9. CEMENT STORAGE AND SHIPPING

The group of eight new 25,000 barrel cement silos are elevated to allow drive through loading for both truck and rail.

The cement withdrawal system is designed for rapid, dust free loading. The silo hoppers are equipped with air pads and air jets to maintain cement flowability through rotary valves. Loading is done by air conveyors to flood-proof screws which feed 4' x 8' screens with 3/8" openings. The truck scales have a 75 ton capacity and a 110' platform. A 200 ton, 110' long scale is used to load both trucks and railroad cars.

A centrally located room between the scales contains the scale consoles, scale dials and ticket printers. Aeration of the bins and setting up of the loading circuit is accomplished by a single selector.

The original group of silos consist of nine 9,000 barrel and four 2,000 barrel silos. These supply cement for the sack packing operation. Cement is transferred from this group by 8" pump to the old bulk loading tanks. These five tanks (with rail and truck scales) are used for specialty cements. The 8" pump is also used to load bulk cement barges.

The sack packing is handled with three packing machines.

10. PROCESS WATER

The new finish mill operation reclaims all water and is cooled by a cooling tower. Make up water for this system is furnished by the city.

All storm drainage and bearing cooling water is collected in a tank and this water is used for the dust system as well as for make up water for the raw mills.

11. PLANT AIR

The high pressure air compressors are essentially for control of equipment in the new section of the plant. Therefore, each group of silos and the finish mill building have their own compressors. The packhouse and scale tanks also have individual compressors. The remaining departments are supplied by one high pressure compressor with a standby compressor. Low pressure air for the slurry tanks is supplied by one compressor located in the raw mill building.

12. NOTES OF INTEREST

There are thirty-six bag type dust collectors throughout the plant.

There is no discharge of water or waste material to the river.

Two sanitary sewage pump stations discharge to the city sewer system.

Vacuum cleaning systems have been installed in the new silo group and finish mill building.

Two street sweepers keep the roadways and scales clean.

1. ELECTRICAL INTRODUCTION

The Seattle Plant of Lone Star Cement Corporation is in fact two separate electrical systems. The "Old Plant" having its own main power panel and distribution system, and the "New Plant Facilities" with a main power panel and indoor switchgear located in the new mill building.

The original power for the entire plant was supplied by Seattle City Light, a member of the Bonneville Power Pool. Power entered the plant on overhead lines to three single phase 1,000 K.V.A. 26 KV/2.3 KV transformers located near the old plant mill building which houses the 2,300 volt switchgear panel.

Emergency power was also available from City Light through a separate overhead line south of the plant. This line fed three single phase 100 KVA 4.16KV/2.3 KV transformers which could be switched into the old plant main buses.

Both of these systems were removed in 1969 and replaced by a 3,750 KVA 3 Ø 4160/2400 volt Delta Star transformer located west of the old mill building. The primary side is carried in rigid conduit from a 1,200 ampere ACB located in the new mill building switchgear room. Ammeter, watt hour meter, and necessary overload protection devices for old plant power supply are located in the new mill building.

2. MASTER OUTDOOR SUBSTATION

A new "Master Outdoor Substation" located east of the new mill building now supplies all electrical power for the plant. An underground four inch rigid conduit enters the plant from City Light's overhead power line approximately 600 feet east of the substation.

Inside the fenced substation area are the 7,500/9375 KVA 26.4/4.16 KV 3 Ø Star Delta transformer and metering shed. The transformer and metering equipment are owned by the Seattle City Light. The outdoor transformer is cooled by extended radiators and five forced air fans. Thermostats in the insulating oil control the fans.

Located in the metering shed, a 2,000 ampere ACB relays 4160 volt power to

the main buses in the new mill building switchgear room. Transformer and incoming line are protected by a ground overcurrent relay, time overcurrent relay, and instantaneous overcurrent relay, which will open the 2,000 ampere ACB.

3. 4160 VOLT POWER PANEL & DISTRIBUTION

The indoor 4,160 volt switchgear is centrally located on the second floor of the new mill building and consists of factory assembled, standardized metalclad units with a bus rated at 2,000 amperes. The air circuit breakers have 250 MVA interrupting capacity, 80,000 RMS amperes momentary short circuit duty. Control voltage is 48 V.D.C. supplied by a remotely located bank of lead-acid batteries. The incoming line breaker is rated 2,000 amperes and all seven feeder breakers are 1,200 amperes. Auxiliary control cubicles are located adjacent to the ACB's used for starting the 2,500 H.P. synchronous mill motors and they contain excitation power transformers, solid state rectifiers, field contactors and field application control equipment. The main 4.16 KV switchgear contains all the necessary auxiliary equipment, meter recorders, and protective relays to create a well-coordinated and safe distribution system.

The 4.16 KV resistance grounded distribution system serves five load center transformers which range in capacity from 750 KVA through 3750 KVA, two 4 KV synchronous mill motors of 2,500 H.P. each and two 4 K.V. induction motors of 250 H.P. each.

4. LOAD CENTER TRANSFORMERS

Load center transformers installed in the plant are located in areas served. All transformers have 4160 volt Delta connected primaries, 480 volt Star connected secondaries, except the old plant transformer which is 2,300 volt secondary. Secondary neutral points are solidly grounded except for the old plant transformer.

All the indoor transformers installed with the new plant facilities have secondary breakers as integral parts of the transformers. The one outdoor type transformer at the old mill building has a secondary OCB rated 1,200 amperes located in main panel switchgear.

5. 2,300 VOLT POWER DISTRIBUTION

2,300 volt power distribution throughout the old part of the plant is through nine OCB's in the main panel switchgear located in the north end of the old mill building. Five of these OCB's are rated 300 amperes and feed six transformer stations with 480 volt secondaries in various sections of the old plant.

In addition to the transformers, twelve 2,300 volt motors with H.P. ratings 60 to 100 are across the same OCB's. One O.C.B. rated 500 amperes feeds a 225 KVA transformer at the secondary crusher, and a 150 H.P. 2300 volt crusher drive motor.

The three remaining 300 ampere OCB's are used as starters for the three 750 H.P. super synchronous motors which drive the two raw mills and one finish mill in the old part of the plant.

6. 4000 VOLT MOTORS

The largest electrical drive units in the plant are the two finish grinding mill synchronous motors, located in the new mill building. They are rated 2,500 H.P. 4000 volts, 3 Ø, 514 R.P.M.

The motors are pedestal type with two sleeve bearings and have open self-ventilating enclosures. Stator shift is provided to facilitate motor inspection and maintenance. Both mills have pneumatically operated clutches between drive motor and Symetro gear reducer, and the clutch control can be applied only after the motor has been started and is running synchronously.

The motors are furnished with 440 volt space heaters, which are automatically switched on when the motor is shut down. Embedded in each motor stator are five resistance temperature detectors. RTD's are also located in motor front and rear bearings. All seven RTD's are wired to sound alarms at operators control panel.

Excitation voltage of the synchronous motors is 250 V.D.C. furnished by individual solid state rectifiers in main 4160 volt switch gear cubicles. The two mill motors are started by individual 1200 ampere ACB's located in the 4160 volt switch gear. Spotting of the mills is accomplished locally from individual local control panels. Protection for the synchronous mill motors includes instantaneous over-current relays, thermal and time-overcurrent relays, under-voltage reverse phase check relays, current balance and incomplete sequence relays. Stator windings of the motors are protected against abnormally high voltage surges by installation of capacitors, connected directly on the motor terminals at the motor pit.

Two 4,000 volt 250 H.P. 600 R.P.M. squirrel cage type motors are used to drive the air separators. Both motors are ball bearing with open dripproof enclosures. Each motor starter has a gang operated isolating switch for personnel protection, current limiting fuses and thermal over-current relays for motor protection.

7. 2,300 VOLT MOTORS AND STARTERS

Three identical 2300 volt 750 H.P. 180 R.P.M. super synchronous motors with 125 volt D.C. excitation are used to drive three ball grinding mills in the old mill building. These motors are manually started by means of hand levers and connecting rod linkage to the 2300 volt OCB's in switchgear panel. First step in the starting process is to bring the free rotating stator to synchronous speed with an auto transformer, then 2300 volts is applied to the stator windings, last step 125 volts D.C. is applied to the rotor coils. (A motor generator set supplies the 125 V.D.C.)

The rotor is connected directly to the drive gear of the ball mills. Motor torque is transmitted to the drive gears by slowly braking the rotating stator by means of a 360° brake band assembly. As the stator is slowly braked the rotor begins to turn and with stator stopped, rotor is at synchronous speed of 180 R.P.M.

The plant's two kilns are each driven by a 60 H.P. 2300 volt 900 R.P.M. wound rotor motor with speed regulating controls located at kiln burning floor. Three air compressors, one cement pump and two motor generator sets are also driven by 2300 volt motors with a range of 100 to 60 H.P.

8. 480 VOLT MOTOR CONTROL CENTERS AND CONTROLS

Secondary power distribution in the plant is at the 480 volt level. To provide reliable electrical control of motors and miscellaneous electrical equipment, multi-unit metal-clad assemblies are used as 480 volt power distribution and motor control centers. There are twelve MCC's utilized in the plant. Five of these are located in the new portion of the plant and seven

in the old part of the plant.

Except for some local department operations, all motors are normally started and stopped from central control rooms or central control operating areas which secure sequence interlocking of equipment involved and provides automatic starting of machinery. Local operation of individual motors is possible via pushbuttons at the motor when the respective "Local-Off-Remote" selector switch at the MCC is placed in the "Local" position. Because of incomplete interlocking of equipment the "Local" mode of operation is used only in emergency, or for equipment testing. All motors can be stopped in an emergency by operating the Stop pushbutton at the motor.

9. MISCELLANEOUS ELECTRICAL EQUIPMENT

Considerable amount of electrical equipment, other than motors and their controls, are used in the production of Portland cement. Some of these are briefly described as follows:

1. An electrostatic precipitator is used to remove dust particles from the kiln exhaust gases before they enter the stack. This unit consists of three transformer-rectifier sets, each with 400 volt primary, 50,000 volt secondary, 600 MA output, oil filled and silicone half wave rectifiers. Connected in series with the primary of the precipitator transformer, a saturable reactor automatically controls the voltage to maintain the highest possible output voltage on the discharge electrodes.

2. An electronic tramp iron detector protects the secondary rock crusher from stray metal objects by shutting down the feed belts when scrap iron passes beneath it.

3. Raw mill feed hopper filling is watched remotely by the operator through a closed circuit TV camera and monitor.

4. Both kilns have numerous electrical instruments to assist the operator in kiln burning, such as oxygen analyzers, temperature indicators, gas flow meters, slurry density meters and control.

5. Both new finish grinding mills are protected by inlet and outlet bearing temperature sensors which continuously indicate the temperature and will automatically shut down if pre-set temperatures are exceeded. Electrical sensors are also installed to detect bearing wear in the symetro gear reducers and will shut the mill down if wear or movement is excessive.

6. A complex electronic system regulates the feed rate for the new finish mill. As many as three separate feeders, and one return weigh screw are integrated electronically to feed a pre-set amount of material into the mills over a wide tonnage range.

7. Clinker and gypsum feed from storage silos is regulated by eight 7 KW vibrating feeders with adjustable speed control. Supply voltage for these units is 440 volt.

10. PLANT COMMUNICATIONS

In addition to the standard telephone system necessary for external plant communication, an internal telephone system exists throughout the plant and is maintained by the telephone company.

Jacks for sound-powered telephones are provided in all motor control center rooms and other key electrical areas of the new plant facilities for use in maintenance and trouble shooting. Portable two-way C.B. radios are also available for checking remote controlled equipment and trouble shooting.

11. ELECTRICAL SAFETY

Every effort has been made to safeguard plant personnel from electrical dangers, Equipment has been installed per national and local safety codes. Stop buttons are located at or near all motors. Long conveyor belt systems have stop pull cords mounted along the frames. Transformers are mounted in closed rooms or behind fenced areas. Areas of electrical danger and high voltage are marked with appropriate signs. Remotely started pieces of equipment have area warning horns that sound before motors start. Plant lighting is arranged and maintained to make night working conditions as safe as possible.

12. SUMMARY

It would be impossible to cover all electrical equipment used in Lone Star's Seattle Plant within the scope of this article. However, the writer feels that major systems have been mentioned.

In the past, plant electrical equipment and methods have been improved as new and more efficient electrical apparatus became available. No doubt the same action will be taken with today's equipment to maintain a modern, economical, and efficient plant in the future.